

What is claimed is:

1. A perpendicular magnetic recording medium, comprising:
  - a substrate;
  - a soft magnetic underlayer formed on said substrate;
  - a nonmagnetic intermediate layer formed on said soft magnetic underlayer; and
  - a perpendicular recording layer formed on said intermediate layer,wherein said soft magnetic underlayer contains Fe, Ta and C, and a concentration of said Ta ranges from 8 at% to 15 at%.
2. The perpendicular magnetic recording medium according to claim 1, wherein a ratio of the concentration of Ta to a concentration of C (Ta concentration/C concentration) ranges from 0.5 to 0.9.
3. The perpendicular magnetic recording medium according to claim 1, wherein a nonmagnetic amorphous or nanocrystalline pre-coating layer is provided between said substrate and said soft magnetic underlayer.
4. A perpendicular magnetic recording medium, comprising:
  - a substrate;
  - a soft magnetic underlayer formed on said substrate;
  - a nonmagnetic intermediate layer formed on said soft magnetic underlayer; and
  - a perpendicular recording layer formed on said intermediate layer,wherein in-plane coercivity  $H_c$  (298K) of said soft magnetic underlayer is 1 Oe or less and in-plane coercivity  $H_c$  (173K) of said soft magnetic underlayer is 3 Oe or more, the in-plane coercivity  $H_c$  (298K) being measured while applying magnetic field along a head running direction at a temperature of 298 K, and the in-plane coercivity  $H_c$  (173K) being measured while applying magnetic field along the head running direction at a temperature of 173 K.
5. The perpendicular magnetic recording medium according to claim 1, wherein in-plane coercivity  $H_c$  (298K) of said soft magnetic underlayer is 1 Oe or less and in-plane coercivity  $H_c$  (173K) of said soft magnetic underlayer is 3 Oe or more, the

in-plane coercivity Hc (298K) being measured while applying magnetic field along a head running direction at a temperature of 298 K, and the in-plane coercivity Hc (173K) being measured while applying magnetic field along the head running direction at a temperature of 173 K.

6. The perpendicular magnetic recording medium according to claim 2, wherein in-plane coercivity Hc (298K) of said soft magnetic underlayer is 1 Oe or less and in-plane coercivity Hc (173K) of said soft magnetic underlayer is 3 Oe or more, the in-plane coercivity Hc (298K) being measured while applying magnetic field along a head running direction at a temperature of 298 K, and the in-plane coercivity Hc (173K) being measured while applying magnetic field along the head running direction at a temperature of 173 K.

7. A magnetic storage apparatus, comprising:

the perpendicular magnetic recording medium defined in claim 1;

a driving section for driving said perpendicular magnetic recording medium in a recording direction;

a magnetic head having a recording section and a reproduction section;

a unit for allowing said magnetic head to relatively move with respect to said perpendicular magnetic recording medium; and

a recording/reproduction processing unit for receiving a signal of said magnetic head and reproducing an output signal from said magnetic head,

wherein the reproduction section of said magnetic head is constituted by a high sensitivity element utilizing a magnetoresistance effect or a tunneling magnetoresistive effect.

8. A magnetic storage apparatus, comprising:

the perpendicular magnetic recording medium defined in claim 4;

a driving section for driving said perpendicular magnetic recording medium in a recording direction;

a magnetic head having a recording section and a reproduction section;

a unit for allowing said magnetic head to relatively move with respect to said

perpendicular magnetic recording medium; and

a recording/reproduction processing unit for receiving a signal of said magnetic head and reproducing an output signal from said magnetic head,

wherein the reproduction section of said magnetic head is constituted by a high sensitivity element utilizing a magnetoresistance effect or a tunneling magnetoresistive effect.